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ABSTRACT

This study examines the effect of intensive, content oriented summer workshops and implementation workshops upon 87 teachers. The curriculum for the workshops was based upon the Mathematics-Method Project materials, which coordinate the methods and content disciplines using small group activities. The significant differences (p less than .05) found in the affective domain based on control group contrasts were attributed to the intensive summer experience. The extensive approach utilizing content materials coordinated with teaching methodology was deemed to be a promising model for in-service training. However, the academic year workshops must be directly related to and a logical extension of the summer workshops if the combined effect of these two training apporaches is to have maximum impact. The authors also cite the need for future studies designed to identify effective in-service training strategies. Since the employment trend limits the entry of recent graduates to the teaching profession, in-service training must be extended to introduce innovations, and effective training models must be developed and tested. (Author/SD)

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The Effect of Extended In-Service Training Curricula Upon the Mathematics Achievement and Attitudes of Elementary Teachers

(1976 AERA Session No. 7.02: Updating Teacher Knowledge and Use of Curricula)

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Paper presented at the Annual Meeting of the American Education Research Association (AERA), San Francisco, April 1976. The original study was supported by funds provided by the National Science Foundation (NSF) under Grant No. EPP74-14535 A02.

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ABSTRACT

The Effect of Extended In-Service Training Curricula Upon the Mathematics Achievement and Attitudes of Elementary Teachers

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This study examines the effect of intensive, content oriented summer workshops and implementation workshops upon 87 teachers. The curriculum for the workshops was based upon the Mathematics-Method Project materials, which coordinate the methods and content disciplines using small group activities. The significant differences ($p < .05$) found in the affective domain based on control group contrasts were attributed to the intensive summer experience. In light of the findings, the extensive approach utilizing content materials coordinated with teaching methodology was deemed to be a promising model for in-service training. However, the academic year workshops must be directly related to and a logical extension of the summer workshops if the combined effect of these two training approaches is to have maximum impact.

The authors also cited the need for future studies designed to identify effective in-service training strategies. Indeed, educational innovations related to elementary school programs can no longer rely on the new teachers to reflect current university activities in this area as the employment trend severely limits the entry of the recent graduate to the teaching profession. Consequently, in-service training must now be extended to span the void and effective training models must be developed and tested.

Purpose of this Study

The major purpose of this study was to determine the effect of two approaches to in-service training[1] on the mathematics achievement and attitudes of primary and elementary grade teachers. In the first approach to training, the Full Group training model, selected teachers were exposed to an intensive summer workshop and to a series of implementation workshops during the following academic year. In the second approach to training, the Restricted Group training model, selected teachers were exposed to workshop training during the academic year only. The summer workshops, which were conducted for four hours per day over a four week period (20 sessions in all) focused on both the mathematics content taught in the elementary school (including such topics as numeration, addition-subtraction, awareness geometry, multiplication-division, transformational geometry and rational numbers) and procedures for teaching this content. The academic year workshops for both Full and Restricted group teachers were held separately in seven after-school sessions of 2½ hours duration and consisted primarily of instruction in the use of innovative procedures for the teaching of mathematics (e.g., the use of Geoboards, Cuisenaire Rods, Attribute Blocks, etc.)

The curriculum materials used at the workshops were subsets of the materials developed by Indiana University mathematicians and mathematics educators in the course of the NSF-supported Mathematics-Methods Project (MMP). The cornerstone of these materials, which were originally developed for use with pre-service teachers, is a series of instructional units.

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[1] The training portion of this research was conducted by Dr. Richard Kratzer of the University of Maine at Portland-Gorham under a separate grant with the National Science Foundation. The authors of this paper wish to thank Dr. Kratzer for his cooperation in the research aspects of the project.

Each of these units is an instructional package comprised of materials, activities, and procedures related to a given topic which are necessary to teach the mathematics content, the related elementary school content, and the techniques appropriate for teaching elementary school pupils that particular content. Users of the materials are trained to teach mathematics by working with these units in a activity-oriented laboratory setting. Discovery learning and small group problem-solving are emphasized.

Procedures

Sample

Teachers participating in this study were drawn from four rural school districts in the vicinity of Portland, Maine. Full and Restricted Group teachers were volunteers from three of the districts; Control Group teachers were volunteers from a fourth district. Because of limited district size, both Full and Restricted participants taught within the same school in most instances. The distribution of teachers by group and grade level is presented in Table 1.

Table 1

Distribution of Cooperating Teachers
By Grade Level and Treatment Group

	Treatment Group			
Grade	Full	Restricted	Control	Totals
1	5	7	3	15
2	5	5	4	14
3	2	6	4	12
4	6	5	4	15
5	7	6	4	17
6	6	4	4	14
Totals	31	33	23	87

Instrumentation

Teacher achievement in mathematics was measured by a 37-item test developed at Indiana University for the Mathematics-Methods Project. Based on pre-tests administered to the 87 participating teachers, the internal consistency (as measured by the Kuder-Richardson Formula 20) of the single-form instrument is .74. Based on test results of the Restricted and Control Group teachers (n=56) who did not participate in the summer workshop, the coefficient of stability for this instrument is .84 across a five month period.

Teacher attitudes towards mathematics were measured with the recently developed Mathematics Attitude Scale (Aiken, 1974). This five-point, Likert-type scale is composed of two subscales. The first subscale, which consists of eleven items, measures Enjoyment of Mathematics. The second is comprised of ten items designed to assess the Value of Mathematics. Alpha coefficients reported by Aiken for the two subscales are .95 and .85, respectively, but other evidence supporting the two-factor structure of the instrument has not been reported. Therefore, pre-treatment data were used to judge the suitability of the factor structure and corresponding scoring procedure proposed by Aiken.

Factor analysis results (n=96) supported a three-factor rather than a two-factor solution using 18 of the original 21 items (see Table 2). The three items dropped (items 3, 13 and 15) were excluded primarily because their correlation with respective subtest scores was low. One item which Aiken considered to be an Enjoyment item was not included in the current scoring system. However, since eight of the remaining ten

Enjoyment items load on the first factor, the nine-item solution will also be labelled Enjoyment of Mathematics. Seven of the eight items loading on the second factor Aiken classifies as Value items. Therefore, this factor will also be labelled Value of Mathematics. The third factor consists of six items. One of these items also loads on the Enjoyment factor, four items also load on the Value factor, and one item loads exclusively on this last factor. Since the emphasis of these items, taken as a group, appears to be on subsequent uses and value of mathematics, this factor is referred to here as the Future Value of Mathematics factor. Estimates of internal consistency (alpha coefficient) for these factors were .93, .83 and .78, respectively. A simple summation of the items whose loading on a factor was .35 or greater was used to score each of the three subscales.

Table 2

Attitude Toward Mathematics Scale
Classical Factor Analysis Solution (N=96)

Rotated Factor Matrix

Item	Factor 1	Factor 2	Factor 3
1	0.27423	0.48978	-0.00936
2	0.82605	0.18173	0.10403
4	0.81629	0.24109	0.12396
5	0.38609	0.16774	0.64189
6	0.22567	0.16727	0.67249
7	0.79681	0.28467	0.15536
8	-0.23746	-0.53788	-0.31631
9	-0.17335	-0.68848	-0.11022
10	0.11838	0.61634	0.32036
11	0.70123	0.22120	0.25609
12	0.11739	0.33908	0.42505
14	0.00148	-0.53961	-0.31562
16	0.11838	0.48471	0.29353
17	-0.45342	-0.21340	-0.24991
18	-0.86957	-0.11968	-0.23495
19	-0.84866	-0.13642	-0.10827
20	0.26221	0.75280	-0.03086
21	-0.79912	-0.11966	-0.17409

Teacher attitudes toward the teaching of mathematics were measured using a modification of the McCallon-Brown Scale (McCallon and Brown, 1971). This semantic differential type instrument was originally developed to measure attitudes toward mathematics. To address the concept "Teaching Mathematics," the stem phrase "To me, mathematics is " was changed to "To me, teaching mathematics is." The 15 bi-polar adjective pairs used by McCallon and Brown were retained, as were the 7-point rating scale and item order. Because this revision of the instrument was in the experimental stage of development, item analytic and factor analytic techniques were used to arrive at a meaningful scoring strategy.

Initial factor analyses of the teaching mathematics scale were performed on the pre-test data for teachers in all groups (May, 1974 testing). Using a principal component model, a three-factor solution was found. However, several items loaded on two or more factors. A review of the item analysis results for the 15-item scale revealed that items 5 and 6 had item-total correlations of .29 and .20, respectively. Since these two items also had split factor loadings, they were eliminated from the scale. Factor analyses of the remaining 13 items were performed using a principal component model and a classical model with squared multiple correlations in the diagonal. Every item loaded on one factor for both solutions. Finally, a quartimax rotation was applied. Again, each item loaded on the first factor. However, as can be seen in Table 3, item numbers 2, 3 and 11 of the 13-item scale also loaded on a second factor. In each case, however, the

greater loading was associated with Factor I. Further, Factor I accounted for 91% of the common variance and had an internal consistency (coefficient alpha) of .93. These analyses were replicated using the Restricted and Control Group teachers' responses to the October, 1974 administration of the instrument plus the ratings of 38 teachers gathered in a mathematics education class in Maine. The solution for these 84 observations resulted in the first factor accounting for 93% of the common variance. As a result, a single factor solution for the scale was adopted. Teachers' scores on the Attitude Toward Teaching Mathematics scale were, therefore, a summation of the 13-item scores, using reverse scoring where appropriate.

Table 3

Attitudes Toward Teaching Mathematics Scale
Final Factor Structure with Item-Total Correlations

(Quartimax Rotated Factor Matrix, N = 96)

	Factor Loadings			
Item Number on Scale	Factor I	Factor II	Communality	r with total score
1	.75	-.27	.64	.72
2	-.70	.40	.65	.64
3	-.58	-.39	.49	.55
4	-.63	-.17	.43	.67
7	.82	.07	.67	.83
8	.68	-.05	.46	.65
9	.63	.21	.44	.61
10	.86	.02	.74	.83
11	-.72	.19	.55	.79
12	.85	-.14	.74	.82
13	.52	.38	.42	.56
14	.46	-.01	.21	.44
15	.78	.04	.62	.75

Data Collection

The achievement and attitude scales were administered to all subjects prior to the summer workshop (May 1974), at the start of the academic year workshops (October 1974), and at the end of the academic year (May 1975). Where testing could not be scheduled during workshop sessions, teachers were tested as close to their schools as possible and were paid $10.00 for their cooperation.

Analysis of Data

Analysis of covariance (ANCOVA) procedures were used to determine the impact of the workshops on teacher achievement and attitudes. Because three treatment levels (Full, Restricted and Control) and two teaching levels (Primary, consisting of teachers of grades 1-3, and Intermediate, consisting of teachers of grades 4-6) existed, a 3x2 ANCOVA with the respective pre-test measures as covariates was employed. When the effect of the summer workshops only on teacher achievement and attitudes was investigated, May, 1974 results were used as the covariates and October, 1974 data served as the criterion. When the differential effects of the summer and school year workshops combined and the school-year workshops alone were investigated, May, 1974 results were used as the covariate and May, 1975 data served as the criterion. All null hypotheses of no differences among the groups were tested at the .05 level of significance.

Results

Effect of the Summer Workshop Alone

The results of the analysis of the May, 1974 and October, 1974 achievement data are presented in Table 4. As can be seen in the table, slight but non-significant ($p = .05$) pre-post gains were found for the group participating in the summer workshops (the Full Group). Therefore it must be concluded that the summer workshops had no significant immediate effect on teacher achievement.

The analysis of the effects of the summer workshop alone on teacher attitudes toward mathematics and the teaching of mathematics are presented in Tables 5, 6, 7 and 8. Tables 5 through 7 present the results for the three factors of the Aiken Attitude Toward Mathematics Scale. Table 8 presents the results related to attitudes toward teaching mathematics.

Table 4

Means, Standard Deviations, and Analysis of Covariance For The Effect of the Summer Workshop on Teacher Achievement with The Indiana Test as the Criterion

Cell Means and Standard Deviations

Treatment Group	Teaching Level	N	Covariate[1] mean	Covariate[1] s.d.	Criterion[2] unadjusted mean	Criterion[2] unadjusted s.d.	Criterion[2] adjusted mean
Full	Primary	12	14.50	3.48	15.58	3.78	17.09
	Intermediate	19	19.63	4.51	20.63	4.69	18.04
Restricted	Primary	18	15.89	5.02	15.61	4.82	16.01
	Intermediate	15	17.33	4.27	17.53	4.29	16.78
Control	Primary	11	16.64	5.50	16.27	5.27	16.07
	Intermediate	12	14.33	3.82	15.08	2.68	16.72

Analysis of Covariance

Source	df	MS	F-ratio
Treatment Group	2	16.22	2.53
Teaching Level	1	13.10	2.04
Treatment Group X Teaching Level	2	.14	.02
Error	80	6.41	
Total	85		

[1] Pre-tests administered in spring, 1974.

[2] Post-tests administered in fall, 1974.

Table 5

Means, Standard Deviations, and Analysis of Covariance For
The Effect of the Summer Workshop on
Teachers' Enjoyment of Mathematics (Aiken Factor I)

Cell Means and Standard Deviations

Treatment Group	Teaching Level	N	Covariate[1] mean	Covariate[1] s.d.	Criterion[2] unadjusted mean	Criterion[2] unadjusted s.d.	Criterion[2] adjusted mean
Full	Primary	12	29.58	9.18	31.17	8.54	33.36
	Intermediate	19	34.00	7.83	34.53	6.59	33.11
Restricted	Primary	18	31.83	6.60	31.17	6.00	31.52
	Intermediate	14	34.86	4.17	35.14	5.02	33.02
Control	Primary	11	31.73	7.47	31.18	6.63	31.62
	Intermediate	12	31.58	5.63	32.33	6.34	32.89

Analysis of Covariance

Source	df	MS	F-ratio
Treatment Group	2	7.32	.73
Teaching Level	1	18.22	1.82
Treatment Group X Teaching Level	2	6.61	.66
Error	79	10.00	
Total	84		

[1] Pre-tests administered in spring, 1974.

[2] Post-tests administered in fall, 1974.

Table 6

Means, Standard Deviations, and Analysis of Covariance For
The Effect of the Summer Workshops on
Teachers' Views of the Value of Mathematics (Aiken Factor II)

Cell Means and Standard Deviations

Treatment Group	Teaching Level	N	Covariate[1] mean	Covariate[1] s.d.	Criterion[2] unadjusted mean	Criterion[2] unadjusted s.d.	Criterion[2] adjusted mean
Full	Primary	12	34.00	3.46	35.17	2.76	35.34
	Intermediate	19	35.11	2.90	35.11	2.81	33.84
Restricted	Primary	18	34.11	2.30	33.72	2.11	33.83
	Intermediate	14	35.64	3.18	34.14	3.13	34.64
Control	Primary	11	33.00	3.22	33.09	2.47	33.36
	Intermediate	12	33.92	3.26	34.08	2.71	34.30

Analysis of Covariance

Source	df	MS	F-ratio	
Treatment Group	2	13.96	3.38	($p < .05$)
Teaching Level	1	.32	.08	
Treatment Group X Teaching Level	2	2.37	.57	
Error	79	4.13		
Total	84			

[1] Pre-tests administered in spring, 1974.

[2] Post-tests administered in fall, 1974.

Table 7

Means, Standard Deviations, and Analysis of Covariance For The Effect of the Summer Workshops on Teachers' Views of the Future Value of Mathematics (Aiken Factor III)

Cell Means and Standard Deviations

Treatment Group	Teaching Level	N	Covariate[1]		Criterion[2]		
			mean	s.d.	unadjusted mean	s.d.	adjusted mean
Full	Primary	12	24.67	2.31	25.33	1.92	25.56
	Intermediate	19	26.16	1.92	25.68	2.06	24.90
Restricted	Primary	18	24.72	1.45	24.11	1.37	24.30
	Intermediate	14	25.93	2.40	25.64	2.73	25.02
Control	Primary	11	24.18	1.83	24.18	2.41	24.73
	Intermediate	12	24.33	3.00	24.67	2.74	25.11

Analysis of Covariance

Source	df	MS	F-ratio
Treatment Group	2	2.09	.75
Teaching Level	1	.92	.33
Treatment Group X Teaching Level	2	3.79	1.36
Error	79	2.78	
Total	84		

[1] Pre-tests administered in spring, 1974.

[2] Post-tests administered in fall, 1974.

Table 8

Means, Standard Deviations, and Analysis of Covariance For
The Effect of the Summer Workshops on
Teachers' Attitude Toward Teaching Mathematics

Cell Means and Standard Deviations

Treatment Group	Teaching Level	N	Covariate[1]		Criterion[2]		
			mean	s.d.	unadjusted mean	s.d.	adjusted mean
Full	Primary	12	60.67	15.02	65.67	14.02	69.68
	Intermediate	19	65.26	12.63	70.21	9.03	70.63
Restricted	Primary	18	64.94	10.83	64.06	11.43	64.73
	Intermediate	13	68.23	10.35	65.92	11.92	64.03
Control	Primary	11	68.73	7.79	68.64	7.81	66.36
	Intermediate	12	67.00	7.19	67.25	10.45	66.32

Analysis of Covariance

Source	df	MS	F-ratio
Treatment Group	2	267.18	6.13 ($p < .01$)
Teaching Level	1	.11	.00[3]
Treatment Group X Teaching Level	2	5.14	.12
Error	78	43.56	
Total	83		

[1] Pre-tests administered in spring, 1974.

[2] Post-tests administered in fall, 1974.

[3] Rounded to two decimal places.

No statistically significant differences were found for the effect of the summer workshop on either the Enjoyment or Future Value factors of the Aiken scale. In addition, no significant interaction or teaching level effects were found for any of the measures. However, statistically significant main effects were found for the Value factor of the Aiken scale and for the Attitude Toward Teaching Mathematics Scale. The adjusted treatment means across levels[1] on the Value factor were 34.99, 33.60 and 34.07 for the Full, Restricted and Control groups, respectively. Adjusted treatment means across levels for the teaching mathematics dimension were 70.15, 64.38 and 66.34, respectively, for the three groups. Post hoc analyses of these adjusted means, using the Scheffé procedure, revealed that in both cases the Full Group attitude was more positive than the Restricted Group attitude but that no statistically significant differences existed between the Full and Control groups or between the Restricted and Control Groups. Since the Restricted group can be viewed, at this time in the data collection process, as a second control group,[2] these results indicate that the summer workshop did have a significant effect on teachers' attitudes toward the teaching of mathematics and the value of mathematics.

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[1] These values do not appear in the respective table. They represent the treatment group mean collapsed across levels (primary, intermediate).

[2] The reader will remember that no treatment had been applied to the Restricted Group during this testing interval.

School Year Workshop Alone and the Effect
of the Combined Summer and School Year Workshops

The impact of the total program (i.e., summer and school year workshops combined) and of the school year only workshops on the achievement of participating teachers was determined by comparing the data obtained in May, 1974 with the data obtained in May of the subsequent year. ANCOVA results of the analysis of these data are presented in Table 9. As can be seen in this table, a slight pre-post gain was found for both the Full and Restricted groups. However, no statistically significant difference was found for treatment groups for the teaching level of the participants or for the interaction of treatment groups and teaching level. Based on these findings, it must be concluded that neither the total program nor the school year workshop had a significant effect on teacher achievement.

The effect of the total program and the school year workshops alone on teacher attitudes toward mathematics and the teaching of mathematics are presented in Tables 10, 11, 12 and 13. Tables 10 through 12 present the results for the three factors of the Aiken Scale. Table 13 presents the results related to Attitudes Toward Teaching Mathematics.[1]

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[1] The reader will also note that slight pre-post gains on the observed means were found for the Restricted Group. This result is particularly interesting in light of the pre-post losses on these same factors found for the May, 1974 to October, 1974 testing.

Table 9

Means, Standard Deviations, and Analysis of Covariance For The Effect of the Total Program and the School-Year Workshops on Teacher Achievement with the Indiana Test as the Criterion

Cell Means and Standard Deviations

Treatment Group	Teaching Level	N	Covariate[1]		Criterion[2]		
			mean	s.d.	unadjusted mean	s.d.	adjusted mean
Full	Primary	12	14.50	3.48	16.17	3.46	17.80
	Intermediate	19	19.63	4.51	20.63	4.89	17.82
Restricted	Primary	18	15.89	5.02	16.22	5.32	16.65
	Intermediate	15	17.33	4.27	18.33	5.33	17.51
Control	Primary	11	16.64	5.50	16.00	5.67	15.78
	Intermediate	12	14.33	3.82	14.83	3.93	16.61

Analysis of Covariance

Source	df	MS	F-ratio
Treatment Group	2	16.30	1.87
Teaching Level	1	6.47	.74
Treatment Group X Teaching Level	2	1.53	.17
Error	80	8.73	
Total	85		

[1] Pre-test administered in the spring, 1974.

[2] Post-test administered in the spring, 1975.

Table 10

Means, Standard Deviations, and Analysis of Covariance For The Effect of the Total Program and School-Year Workshops on Teacher Enjoyment of Mathematics (Aiken Factor I)

Cell Means and Standard Deviations

Treatment Group	Teaching Level	N	Covariate[1]		Criterion[2]		
			mean	s.d.	unadjusted mean	unadjusted s.d.	adjusted mean
Full	Primary	12	29.58	9.18	31.08	8.62	33.38
	Intermediate	19	34.00	7.83	34.47	7.57	32.97
Restricted	Primary	17	31.76	6.80	31.76	7.12	32.18
	Intermediate	14	34.86	4.17	35.71	4.65	33.47
Control	Primary	11	31.73	7.47	32.73	6.08	33.18
	Intermediate	12	31.58	5.63	34.17	5.47	34.74

Analysis of Covariance

Source	df	MS	F-ratio
Treatment Group	2	9.72	1.02
Teaching Level	1	12.51	1.31
Treatment Group X Teaching Level	2	7.88	.82
Error	78	9.57	
Total	83		

[1] Pre-tests administered in spring, 1974.

[2] Post-tests administered in spring, 1975.

Table 11

Means, Standard Deviations, and Analysis of Covariance For The Effect of the Total Program and School-Year Workshops on Teachers' Views of the Value of Mathematics (Aiken Factor II)

Cell Means and Standard Deviations

Treatment Group	Teaching Level	N	Covariate[1] mean	Covariate[1] s.d.	Criterion[2] unadjusted mean	Criterion[2] unadjusted s.d.	Criterion[2] adjusted mean
Full	Primary	12	34.00	3.46	35.25	3.02	35.43
	Intermediate	19	35.11	2.90	34.89	3.00	34.44
Restricted	Primary	17	34.24	2.31	35.24	2.59	35.28
	Intermediate	14	35.64	3.18	35.93	3.02	35.16
Control	Primary	11	33.00	3.22	34.55	2.73	35.31
	Intermediate	12	33.92	3.26	36.00	2.83	36.23

Analysis of Covariance

Source	df	MS	F-ratio
Treatment Group	2	.77	.15
Teaching Level	1	5.85	1.12
Treatment Group X Teaching Level	2	5.94	1.13
Error	78	5.24	
Total	83		

[1] Pre-tests administered in spring, 1974.

[2] Post-tests administered in spring, 1975.

Table 12

Means, Standard Deviations, and Analysis of Covariance For The Effect of the Total Program and School-Year Workshops on Teachers' Views of the Future Value of Mathematics (Aiken Factor III)

Cell Means and Standard Deviations

Treatment Group	Teaching Level	N	Covariate[1] mean	Covariate[1] s.d.	Criterion[2] unadjusted mean	Criterion[2] unadjusted s.d.	Criterion[2] adjusted mean
Full	Primary	12	24.67	2.31	24.92	2.50	25.13
	Intermediate	19	26.16	1.92	25.47	2.59	24.75
Restricted	Primary	17	24.76	1.48	24.88	2.62	25.03
	Intermediate	14	25.93	2.40	26.21	2.49	25.64
Control	Primary	11	24.18	1.83	24.64	1.86	25.15
	Intermediate	12	24.33	3.00	25.58	2.35	26.00

Analysis of Covariance

Source	df	MS	F-ratio
Treatment Group	2	3.52	.83
Teaching Level	1	1.44	.34
Treatment Group X Teaching Level	2	2.87	.67
Error	78	4.26	
Total	83		

[1] Pre-tests administered in spring, 1974.

[2] Post-tests administered in spring, 1975.

Table 13

Means, Standard Deviations, and Analysis of Covariance For The Effect of the Total Program and School-Year Workshops on Teachers' Attitudes Toward Teaching Mathematics

Cell Means and Standard Deviations

Treatment Group	Teaching Level	N	Covariate[1] mean	Covariate[1] s.d.	Criterion[2] unadjusted mean	Criterion[2] unadjusted s.d.	Criterion[2] adjusted mean
Full	Primary	12	60.67	15.02	67.17	9.52	70.36
	Intermediate	19	65.26	12.63	71.47	9.91	71.81
Restricted	Primary	18	64.94	10.83	66.67	7.32	67.20
	Intermediate	13	68.23	10.35	67.62	10.04	66.11
Control	Primary	11	68.73	7.79	71.27	7.31	69.46
	Intermediate	12	67.00	7.19	70.83	10.67	70.09

Analysis of Covariance

Source	df	MS	F-ratio
Treatment Group	2	161.25	4.34 ($p < .05$)
Teaching Level	1	1.77	.05
Treatment Group X Teaching Level	2	12.52	.34
Error	78	37.12	
Total	83		

[1] Pre-test administered in the spring, 1974.

[2] Post-test administered in the spring, 1975.

No statistically significant main effects or interactions, for either the combined summer and school-year workshops or for the school year workshops alone, were found on any of the three factors of the Aiken Attitude Toward Mathematics Scale. In fact, the adjusted post-test means for the Control Group exceeded the same mean for the other two groups in all instances, and in two of these cases (Value and Future Value) the Restricted Group mean exceeded the comparable Full Group mean. In light of these findings, it appears that the combined summer and school-year workshop and the school-year workshop alone had little effect on the attitude toward mathematics of participating teachers. Furthermore, it appears that a trend toward more positive attitudes toward mathematics for Full Group participants, which began to materialize at the end of the summer workshop, was not nourished by the school-year workshop.

With regard to the participants' attitude toward teaching mathematics, a statistically significant effect for treatment was found. Comparison of the adjusted treatment means across levels for the Full, Restricted and Control Groups (71.08, 66.66 and 69.78, respectively) revealed that Full Group participants were more positively disposed toward teaching mathematics than Restricted Group teachers. However, no significant differences between either treatment group and the Control Group were found. An inspection of the unadjusted pre-test and post-test means across levels reveals gains for all groups, with the Full Group gain

(63.48 to 69.81) exceeding that of either the Restricted (66.32 to 67.07) or Control (67.82 to 71.04) Groups. However, most of the gains for the Full Group could be attributed to their exposure to the summer rather than the school-year workshops. Therefore, despite the statistically significant results, school-year workshops appear to have had little effect on both Full and Restricted Group participants.

Summary and Conclusions

As revealed in the previous section, summer and school-year workshops, either alone or in combination, had no statistically significant effects on the mathematics achievement of participating teachers. Since the Indiana Achievement Test was developed specifically for use with the MMP units, achievement gains were expected on this measure. That significant effects were not found may be attributed to one or more of the following: (1) the major focus of this measuring device is mathematics content while the methodology for teaching that content was emphasized in the workshops; (2) mathematics content is not sufficiently emphasized in the MMP materials; or (3) too much material was covered during the individual workshop sessions.

Obviously, the first of these possible explanations could have been confirmed or denied by including an instrument designed to measure teachers' knowledge and comprehension of various methods for teaching elementary-school mathematics. However, no such instrument was available to the researchers. The second possible explanation has been offered as a criticism of the MMP materials by a number of adopters and has been discussed in a previous evaluation of these materials (Archambault, 1974, p. 143). Given this reaction of college faculty using the MMP with pre-service teachers, it is highly likely that, if this weakness does exist, the lack of sufficient content would be at least as problematic for in-service teachers. The third possible explanation for these

results also appears quite likely since a large number of participants, despite their positive reactions to the workshops, indicated that they were rushed through several of the units.

With regard to teacher attitudes, statistically significant differences in participants' attitudes toward teaching mathematics were found as a result of both summer and school-year workshops. Participants exposed to the summer workshops were found to be more positively disposed toward teaching mathematics than teachers drawn from the same districts who would later be involved in school-year training. Further, summer participants' attitudes toward teaching mathematics also compared favorably, although not statistically significantly, with the same attitudes of Control Group teachers. Given this latter finding and the statistically significant results obtained for comparisons with "secondary control group" teachers (i.e., those who would participate in school-year workshops), it seems safe to conclude that the summer workshop had a positive impact on participating teachers' attitudes toward teaching mathematics.

However, despite the statistically significant results following summer training, the school-year workshop alone and the additional school-year training for summer workshop participants appears to have had little effect on the attitudes toward teaching mathematics of either group. In fact, the results indicate that following involvement in the total program (i.e., summer and school-year workshops) the attitudes

toward teaching mathematics of participating teachers did not differ significantly from the same attitude of Control Group teachers. Further, the difference between the full program and school-year workshop only participants, which accounts for the statistically significant treatment effect, was in large part attributable to gains in attitude resulting from participation in the summer workshop. Given these findings, it appears that the school-year workshop had little impact on teacher attitude toward the teaching of mathematics.

With regard to the impact of workshop training on participants' attitudes toward mathematics, statistically significant results were found for the Value factor at the end of the summer experience. This condition and a trend toward more positive attitudes on the Enjoyment factor which began to materialize near the end of the summer workshop, however, were not nourished by participation in school-year workshops.

In light of the findings in the affective domain, it appears that an extensive approach utilizing content materials coordinated with teaching methodology has promise for in-service training. However, the academic year workshops must be directly related to and a logical extension of the summer workshops if the combined effect of these two training approaches is to have maximun impact.

Finally, the need for future studies designed to identify effective in-service training strategies must be recognized. Indeed, the importance of studies in this area has been markedly increased during recent years.. Educational innovations related to elementary school programs can no

longer rely upon the new teachers to reflect related university activities as the employment trend severely limits the entry of the recent graduate to the teaching profession. Consequently, in-service training must now be extended to span the void and effective training models must be developed and tested.

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